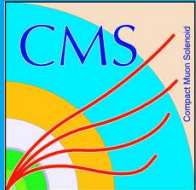


Search for the Higgs Boson Decaying into Tau Leptons (with CMS)

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On behalf of CMS Collaboration

Physics In Collisions Conference 2013,
Beijing





Introduction

- > **H- $\tau\tau$ is important channel**
- > **Probes Higgs coupling to leptons**
 - τ -lepton is heaviest lepton, currently the only sensitive leptonic decay mode
- > **H- $\tau\tau$ is challenging channel**
- > **Low mass resolution ($\sim 15\text{-}20\%$)**
- > **Many final states**
- > **Moriond 2013 results are presented**
- > **4.9 fb⁻¹ at 7 TeV and 19.4 fb⁻¹ at 8 TeV recorded with CMS detector**

Production & Decay Modes

> Higgs production mechanisms:

- $H \rightarrow \tau\tau$ search exploits all production mechanisms

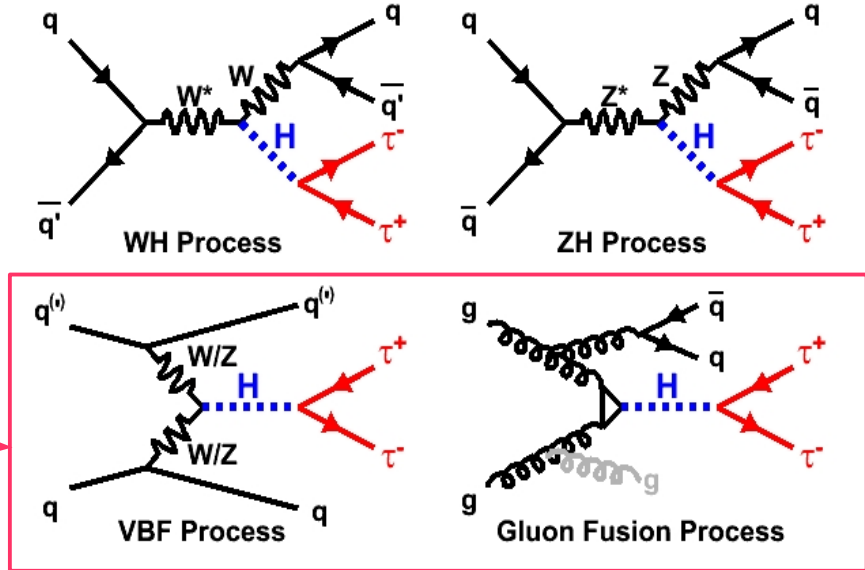
- Sensitivity driven by VBF production

Here focus on

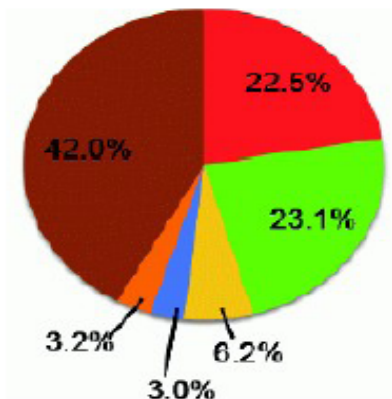
> Analysis covers:

- $H \rightarrow \tau\tau \rightarrow$ had. + had.
- $H \rightarrow \tau\tau \rightarrow \mu +$ had. (most sensitive)
- $H \rightarrow \tau\tau \rightarrow e +$ had.
- $H \rightarrow \tau\tau \rightarrow e + \mu$
- $H \rightarrow \tau\tau \rightarrow \mu + \mu$

+ Missing Transverse Energy



- had + had
- mu + had
- e + had
- e + mu
- mu + mu

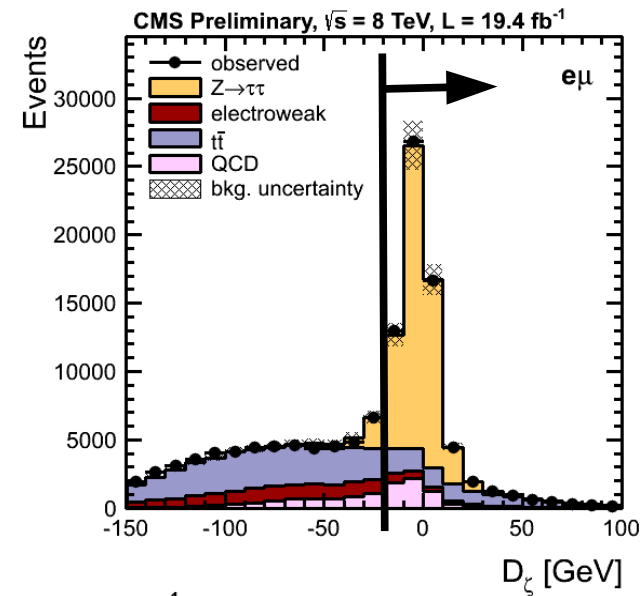
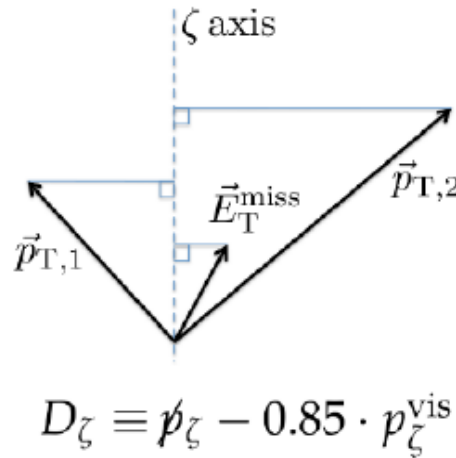


Topological selection

> After basic event reconstruction

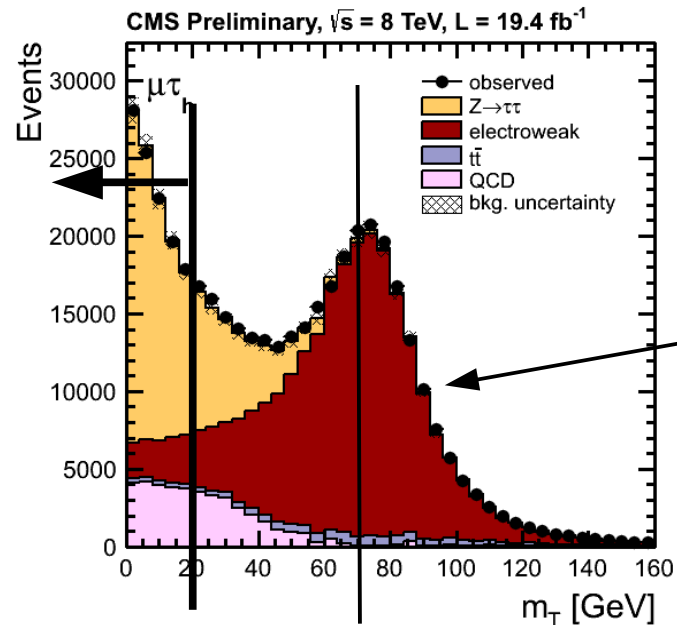
> In $e\mu$ -channel cut on D_ζ :

Reduces $t\bar{t}$ background



> In $l\tau_h$ -channels cut on m_T :

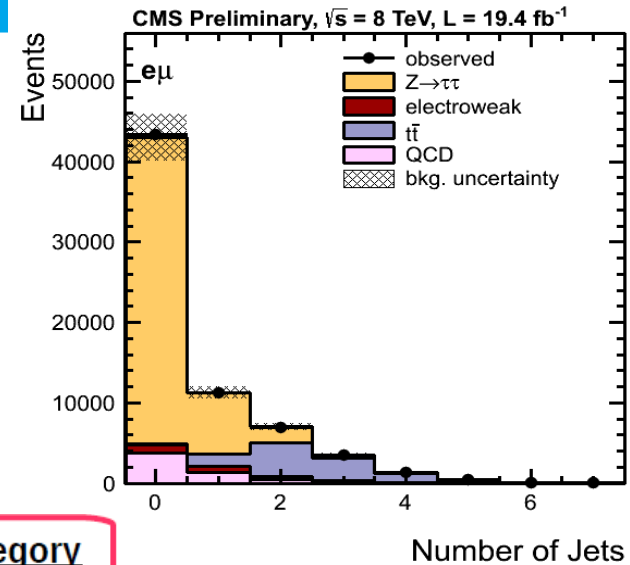
Reduces W +Jets background



Control Region

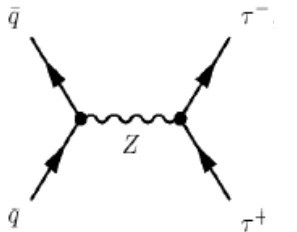
Event Categorization

- > After topological event selection:
- > Enhance sensitivity by event categorization
- > Probe ggH and qqH 'seperately'



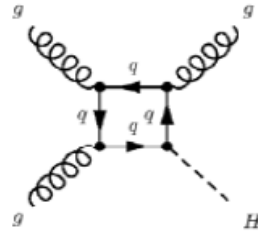
0-Jet Category

- background dominated
- constrains object Id efficiency and energy scale
- calibrates backgrounds



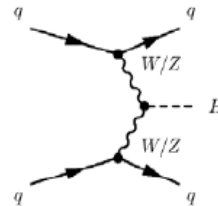
1-Jet Category

- ggH dominated
- boosted Higgs
→ improved $m_{\tau\tau}$ resolution
- Better Z/H- $\tau\tau$ separation



VBF Category

- cleanest mode
- characteristic 2-jet signatures



Split into 2 categories respectively via: $p_{\tau}^{\text{lead}} > 35\text{GeV}$

Most sensitive
Jet-related variables exploited

Categories are complementary

- > $\tau_h \tau_h$ -channel: only 1-Jet and VBF Category (additional jet requirement in trigger)

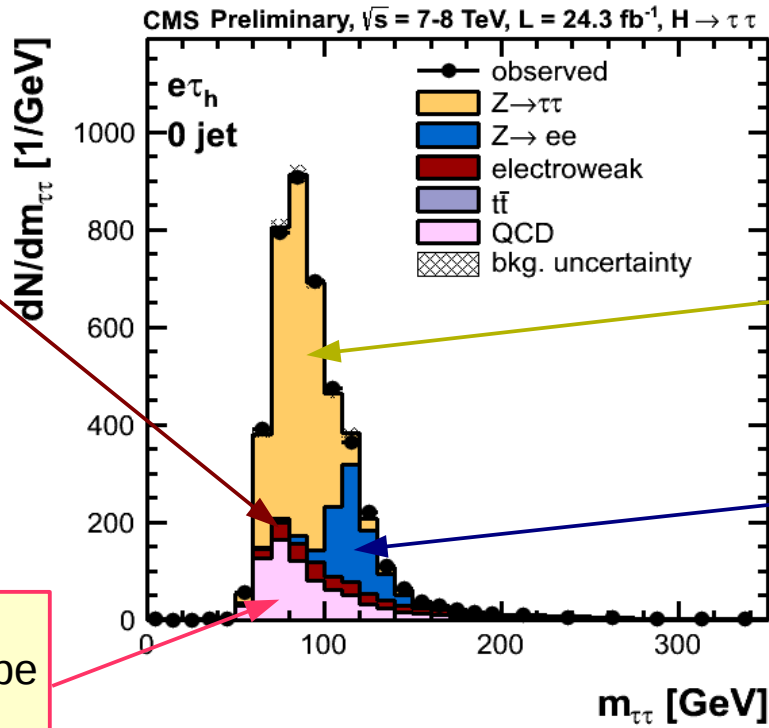
Background estimation

- > $M_{\tau\tau}$ reconstructed via svFit algorithm
- > $m_{\tau\tau}$ used for signal extraction

Wjets/DiBoson:

- Shape from Simulation
- Normalization from Control Region (m_{τ} distribution)

QCD:
Normalization & shape
Data LS/OS
jet- \rightarrow l fake rate

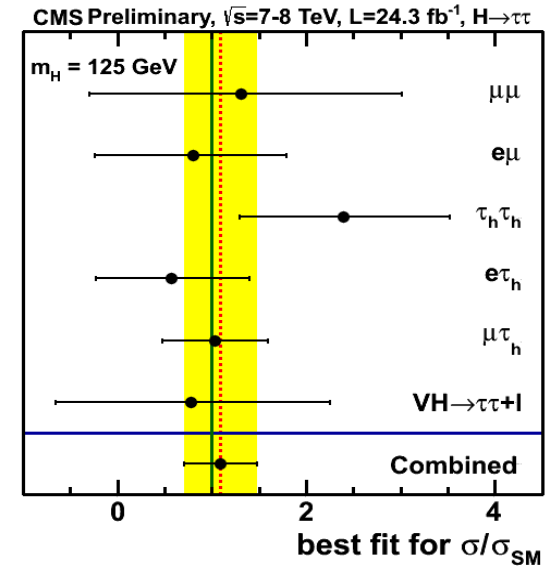
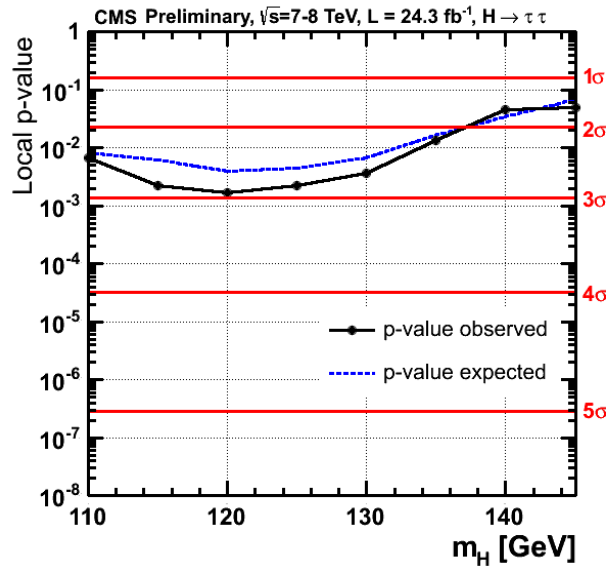
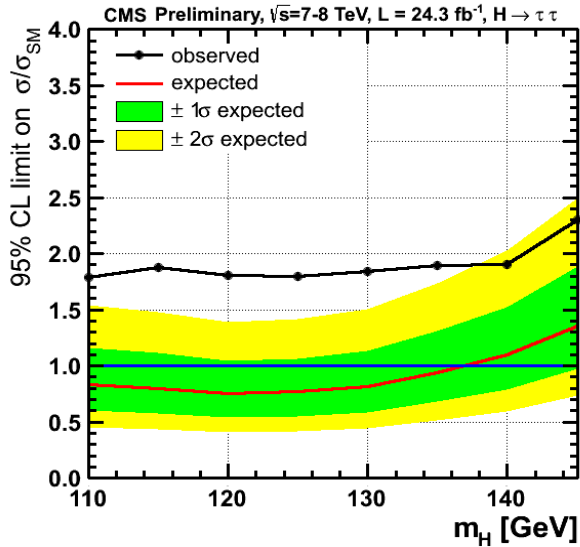


Z- \rightarrow $\tau\tau$:
Embedded Sample,
Data Z- \rightarrow $\mu\mu$,
 μ replaced by sim. τ

DY:

- shape from simulation
- normalized to $l\text{-}\rightarrow\tau_h$ Fake Rate

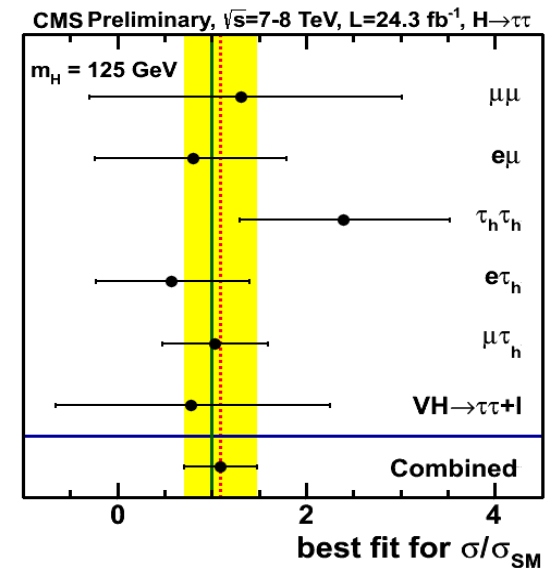
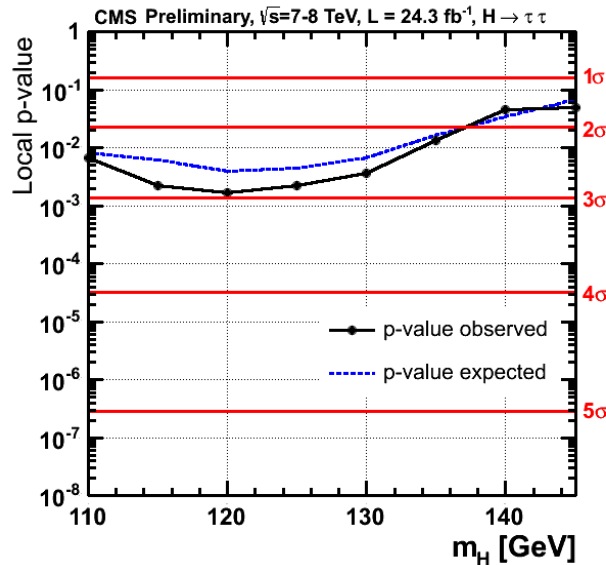
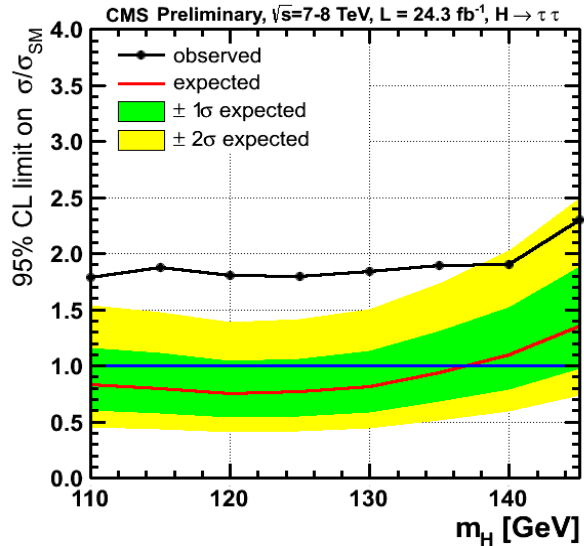
> **Combined fit of $m_{\tau\tau}$ in all categories of all channels**



> **Excess observed, 2.85σ at $m_H = 125.8 \text{ GeV}$, best fit: $\mu = 1.1 \pm 0.4$**

> **Close to probe evidence for Higgs coupling to leptons**

> **Combined fit of $m_{\tau\tau}$ in all categories of all channels**



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> **Close to probe evidence for Higgs coupling to leptons**

Thanks a lot, stay tuned

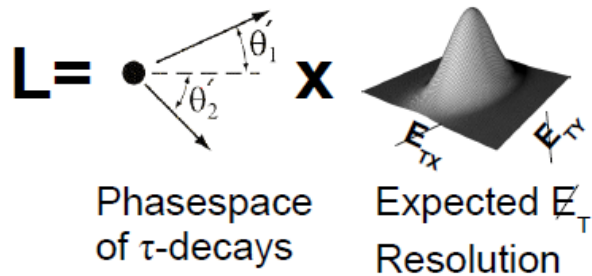
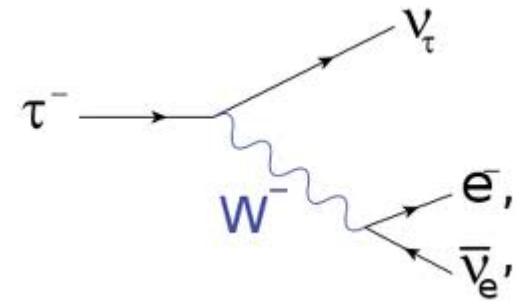


BACKUP

BACKUP

Reconstruction of Di-Tau Mass

- > The measurable observables ($\vec{p}_{vis}^{1,2}$, \vec{E}_T^{miss}) underconstrain full di- τ invariant mass reconstruction
- > Build probability density function and use **Maximum Likelihood Method**



- > For each $m_{\tau\tau}^i$ hypothesis integrate over kernel for given ($\vec{p}_{vis}^{1,2}$, \vec{E}_T^{miss})
- > Perform scan for $m_{\tau\tau}^i$ from m_τ up to 2 TeV
- > **Resolution** of reconstructed $m_{\tau\tau}$ is **15 – 20 %**

